CEMENT
AND
CEMENT MANUFACTURE
INCORPORATING "PORTLAND CEMENT"

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Scientific Research in the Cement Industry.

SOME ten or twenty years ago it had to be admitted that in the matter of scientific research the British cement industry was far behind other nations. There was nothing to compare with the work of Rankin and his colleagues at the Geophysical Institution in the United States, nor were there any Englishmen of the status of Le Chatelier or Michaelis. The reason was not far to seek: there was no public money available for cement research and no manufacturing firm of sufficient magnitude or prosperity to undertake the necessary expenditure for research work.

Research Organisations.

Of late years, however, the position has considerably improved, and although present-day British research does not approach the scope of the work being done in America by the Portland Cement Association and the Bureau of Standards, the expenditure on research per ton of cement produced is probably as great in England as in the U.S.A. with its much greater output. There are now two sources of cement research in England, first that arising from Government grants, and second from the enterprise of the largest cement manufacturing amalgamations. Government money first became available for the support of research in the cement industry in 1919, when the newly-formed Department of Scientific and Industrial Research contributed an annual amount equal to that raised by the cement manufacturers, and the British Portland Cement Research Association was formed.

During a period of seven years over £40,000 was spent on research in this way, and the results obtained were for the most part circulated only to the manufacturers contributing to the scheme. The most important investigations conducted were those on rotary-kiln efficiency and tube-mill efficiency, although there were several side-lines such as the problem of the setting of cement. The work on rotary kilns especially was of considerable benefit, and much of the present efficiency of British kilns is attributable to it. After the Government contributions ceased the British Portland Cement Research Association,

depending as it did upon co-operative working of numerous manufacturers, did not survive. The research establishment and equipment were, however, acquired by the largest British cement manufacturing company, and work on an important scale has been continued to the present day. The results of this later work are naturally a sealed book and can only be guessed at in certain commercial applications such as rapid-hardening Portland cement, white Portland cement, standard elutriator for flour measurement, etc.

In addition to this private enterprise, Government money is being spent on cement research by the Building Research Board at its establishment at Watford, and in this case the information is available to the public. It will be obvious from its name that this institution is concerned with all building materials, but it is evident from the reports and publications that have been issued that cement and concrete form the most important part of the research programme. Among the pamphlets issued, the following titles indicate some of that work that has been done, " Determination of Free Lime in Hydraulic Cement," " Permeability of Portland Cement Concrete," " Consistence of Cement Pastes, Mortars and Concrete," " Pozzolanas."

Gel Structure.

The last issued annual report of the Building Research Board for the year 1927 indicates the lines of investigation and some of the progress that has been made. Based on the fact that the shrinkage of cement during setting and hardening is its outstanding defect as a building material, and that this shrinkage is apparently the result of gel structure, the British Research Station has commenced investigations on the fundamental properties of gels. One of the characteristic properties of gels is their contraction after setting accompanied by exudation of liquid; this phenomenon, known as syneresis, is being studied on silica gel, and the conditions which determine its extent and velocity are being ascertained. The published results do not include any deductions, but two significant observations are recorded: (1) more liquid is syneresed from concentrated gels than from dilute, and (2) the volume of liquid syneresed is equal to the contraction of the gels. If syneresis occurs in cement gels, then the well-known advantage of minimum water content in concrete may be ascribed to the faculty of such concentrated gels to eliminate even the smaller quantity of surplus water they contain and thus lead to further density and greater strength; in fact a cumulative effect, the less the water used the greater the quantity eliminated. Further, if the precise period and amount of syneresis of a cement gel can be determined curing could be arranged to coincide with such period to prevent evaporation of the syneresed liquid, or it is not beyond hope that ultimately some means may be found of using such liquid within the concrete mass to produce further quantities of gel.

Pozzolanas.

Work on the chemical constitution of cement by the Building Research Board has apparently been restricted to investigations on the calcium aluminates, and no results of moment have yet been reported. Important work is in progress in connection with the application of pozzolanas, both artificial and natural.

The use of pozzolanas has hitherto been based on faith in their efficacy to combine with the lime set free during the setting of cement, and thus to remove the disadvantages arising from the presence in concrete of a soluble material. What has been lacking is a means of measuring the " pozzolanic value " or the rate and degree of combination with lime of trass and similar materials, and an electrical conductivity method has now been evolved. With such a test available pozzolanas will rest on a much surer foundation because engineers will no longer have to accept these materials from a description of their origin, but will be able to appraise their value by tests. This facility will be particularly useful in connection with artificial pozzolanas such as burnt clay and oil-shale residues, and there appears to be a possibility of a new industry developing as an adjunct to that of Portland cement, viz. the manufacture of cement-pozzolana mixtures, each component being of a standard quality.

Other research related to cement reported upon by the Building Research Station is of more interest to the concrete user than the cement manufacturer, being concerned with shrinkage stresses and consistency of concrete, joints in concrete, etc., and it is evident that in the matter of cement manufacturing research unless the manufacturer fills the gap there will not be much progress in England.

Problems Awaiting Solution.

There is still great scope for investigations leading to improved quality of product and greater economy in manufacture, and the following is a list of some of the problems awaiting solution.

(1) It is yet to be discovered what are the ideal proportions of lime, silica, alumina and iron oxide in Portland cement.

(2) A cement is needed which will chemically combine with all the water mixed with it to make a paste so that no free water remains to evaporate and cause the crazing and contraction cracks which so frequently disfigure concrete surfaces.

(3) Portland cement liberates hydrate of lime during setting; this is a source of weakness and a cause of the so-called fading of coloured concrete.

(4) As the strength of Portland cement is apparently due to the lower-limed compounds remaining after a certain amount of lime is set free, why should it be necessary to produce a cement containing 63 per cent. of lime in the first instance?

(5) A lining-block for rotary kilns is needed that will withstand successive heating and cooling without loss of thickness.

(6) Means for the rapid transmission of heat from flame to raw material are needed to reduce the inordinate dimensions which modern rotary kiln units attain when high output and good heat efficiency are demanded.

(7) A more efficient means of grinding is required than the present one in which much of the energy spent in grinding is dissipated in heat.

These are some of the outstanding problems that face the research workers in the cement industry and will keep them busy for many years yet. Cement

manufacturers who are in a position to make experiments with commercial-scale kilns and mills are better equipped than the laboratory experimenter who has available only gas or oil-fired kilns or electric furnaces and small mills of no more than batch capacity. Laboratory kilns cannot repeat the conditions occurring in coal-fired rotary kilns, nor can experimental mills of two-feet diameter give any other than comparisons between different sets of experiments. Hence progress in the cement industry on a scientific basis will probably come as the result of full-scale experimental work by the manufacturer following indications suggested by the laboratory worker. While there is no certainty that Portland cement as defined by the standard specification will continue to be the standard commodity for concrete, there can hardly be any doubt that a cement for general use will be made from the materials most readily available, viz. calcareous and argillaceous materials in their many forms of chalk, limestone, clay, shale, and sand. Hence, the Portland cement manufacturer is never likely to be superseded, but it may be necessary on the basis of future inventions to reorganise the processes and the chemical compositions.

Indian Cement Consumption.

The following statement has been issued by the Indian Portland Cement Association: "An estimate of the consumption of Portland cement manufactured in India during the year, November 1, 1928, to October 31, 1929, is 610,000 tons, compared with 556,000 tons during the previous year. The capacity of plants now in operation is 675,000 tons. Future requirements of the Indian market are being anticipated by the extension of existing factories. Works' programmes, most of which are in course of execution, indicate that during 1929-30 the potential capacity of the works of the members of the Association will be 785,000 tons, whereas during 1930-31 985,000 tons is the estimate. Besides this there is room in existing factories for the installation of three additional rotary kilns with a total capacity of, say, 150,000 tons."

Prices and Consumption in Poland.

Zentrocement has increased the price of Polish cement from 8.85 zl. to 9.30 zl. per 100 kilos (40s. 10d. to 42s. 11d. per ton). The consumption of cement during the first half of this year was 5 per cent. (20,000 tons) less than the corresponding period last year.

Prices in Hungary.

The Hungarian cement manufacturers have set up a sales office under the name of the Zement-Verkauf A.G., and have at the same time increased the price of cement.

Indian Standard Specification.

It is reported that the Indian Government intends to issue a new specification for Portland cement.

Experiments on Cellular Cement Mortars.

By Dr. C. R. Platzmann.

Two disadvantages of cement concrete tend to hinder the extension of its use in house construction, namely, its poor insulating qualities both as to sound and heat, and the impossibility of driving nails into concrete walls. To remedy these disadvantages experiments have been made with aggregates which are themselves porous, such as furnace slag, coke ashes, pumice, and other substances whose use has been common in the building trade.

It is the object of this paper to report on two processes that aim to produce a true porous cement mortar. These processes are covered by the U.S.A. Patent No. 1,087,098 and the German Patent No. 327,907. The former patent embodies the principle of adding to cement a material which on the addition of water develops gas. Either metallic aluminium or zinc in the finest possible granules is used, and by the addition of these powders it is claimed that gases are generated to such an extent before the initial set that neat cement will increase in volume by 300 per cent. The chemical reason for this is that the powdered metal and the lime in the cement and the mixing water change to calcium aluminate or calcium-zincate, developing hydrogen. According to the American patent, in order to start this reaction and generation of gases, before the initial set takes place a small quantity of unslaked lime, 0.25 to 2 per cent., is added.

The German patent referred to, while it also employs powdered metallic zinc to form gas, differs essentially from the American process in that besides the metal, which reacts with cement only at comparatively high temperatures, some salt (such as calcium chloride) is added, which reacts strongly with cement at normal temperatures. The effect of the calcium chloride is to hasten the initial set while forming tricalcium-aluminate ($3\ CaO\ Al_2O_3$). This reaction generates more heat* than is created in the setting cement, and, as in the American process, the metal reacts with the cement and water and generates hydrogen. Both processes are based on the known property of some metals to form hydroxides of an amorphous character in wet reactions. That is, toward alkalies and alkaline earths such as lime, they are weakly acid, although they are of basic character toward the more strongly ionised acids.

With the unquestionable interest in light porous cement mortar, it seemed of sufficient importance to experiment with the American process, while the German process was worked out by the writer in conjunction with Dr. F. Killig, Director of the Degerhamm Cement Company, Oeland (Sweden). It seemed possible that by one of these methods a light concrete would be produced suitable for light partition walls, and, as is mentioned in the American patent, for filling in reinforced concrete structures as well as in buildings of all kinds where fire-resistance is desired. For the success of the experiments it was found to be of the utmost importance that the metal used should be powdered

* " Cement and Cement Manufacture," Vol. II, No. 3, March, 1929, page 93.

as finely as possible and that it should be distributed uniformly in the mass of the treated concrete. In an experimental way it was apparent that increased fineness of the metal produced greater increase in volume. A rather coarse-grained aluminium powder produced much less swelling of the mass than very fine grained aluminium powder procured from the aluminium-bronze industry. Additions of stearine and paraffin to these metal powders, which are customary in the industry mentioned, proved of little value in increasing the expansion of the cement mortar.

In the first tests cylinders of 250 cc. content were used. In these was placed a mixture of 100 g. cement containing 0.1 to 0.25 per cent. of aluminium powder previously mixed with 50 per cent. water. After 10 to 20 minutes a violent generation of hydrogen began and the mass began to swell in the cylinder. The action subsided after various lengths of time, depending on the temperature, but never longer than one-and-a-half hours. In the most favourable case the increase in volume was 127 per cent. To save cement, similar trials were made using varying proportions of sand. However, only fine-grained alluvial sand is suitable for this purpose. Coarse-grained sand is not carried upward by the expanding cement; segregation takes place so that a large proportion of coarse sand collects at the bottom of the container, though a very porous mass almost free from sand collects at the top. Since all sand has a high specific gravity, coke ashes were tried as aggregate. The tests gave the following results:—

Table 1.—Cement and Aluminium Powder without Sand.

Test No.	Increase in Volume, per cent.	Duration of Expansion, minutes.	Aluminium Content, per cent.
8	116	40	0.25
12	68	92	0.10
14	70	64	0.10
15	94	65	0.10
19	100	60	0.10
21	125	40	0.10
22	103	44	0.10
23	127	37	0.10
24	98	60	0.10
25	99	60	0.10
27	100	37	0.10
28	95	26	0.10

Table 2.—Cement and Aluminium Powder with Sand or Coke Ashes.

Test No.	Percentage of Aggregate.	Increase in Volume, per cent.	Duration of Expansion, minutes.	Aluminium Content, per cent.
17	30	70	66	0.10
34	75	73	60	0.25
35	75	62	60	0.25
36	75	100*	55	0.25

* Coke ashes

To increase the percentage of metal above 0.25 per cent. proved inadvisable

for several reasons; the metal was not used up, for after the mass had hardened metallic particles were distinctly visible. The expansion was not materially increased, and the reaction was so violent that the gas bubbles forced their way to the surface without increasing the mass.

The effect of the fineness of the metal powder is apparent from the results of tests Nos. 14 and 15, which were conducted with the coarser-grained material. In the tests tabulated in Table 2 the finest-grained powder was used. The addition of sand diminishes the expansion. Without sand the expansion is from 100-130 per cent., with sand 60 to 75 per cent. Finally, test No. 36, made with coke ashes, again showed 100 per cent. increase in volume, which is due to the lower specific gravity of the material.

For the practical utilisation of the process it was of the utmost importance to determine the compression strength of the porous cement mortar at 28 days. Test pieces, cubes of 7 cm., were kept a day in moist air, six days in water, and 21 days in air. It was shown that while very porous cement mortar might be made, the porosity was attained at the cost of strength. In all cases 0.10 per cent. of metal was used, and the following results were attained:—

Table 3.—Compression Strength of Porous Cement Mortar with Different Percentages of Sand (average values).

Quantity of Sand used, per cent.	Compression Strength at 28 days, lbs. per sq. in.
25	985
30	1,098
40	943
50	662
75	239
85	99

It appears, therefore, that additions of sand up to 30 per cent. give the mass a certain strength, while to increase the percentage above 30 per cent. leads to a marked decrease in compression strength. Even if the strength attained does not approach that of ordinary concrete it must be considered that to produce concrete castings such as were used in Table 2 the moulds need to be filled only one-half to three-fourths full, the expansion due to the generation of gases being sufficient to fill them. In the tests conducted, test pieces of 7 cm. cube were used, which were weighted with boards to ensure the complete filling of the cubical shape.

The third point of special interest in the process was the question of specific gravity of the various castings. For this purpose test pieces were cast in the regulation compression briquet (7 by 7 by 7 cm.), in building slabs, and in standard bricks (25 by 12 by 6½ cm.) which were permitted to set and dry

and then weighed. The weight in grammes divided by the contents in cubic centimetres gave the following results:—

Table 4.—Specific Gravity with Different Percentages of Sand.

Test No.	Percentage of Sand.	Specific Gravity.
31	nil	0.76
32	nil	0.85
33	nil	0.76
35	25	1.18
36	25	1.09
27	30	1.32
26	30	1.15
28	30	1.16
37	40	1.17
54	50	0.94
58	50	1.03
67	75	1.21

Comparison with other materials: Tiles, 1.8; cement concrete, 2.0; reinforced concrete, 2.4; pumice concrete, 1.2.

The structure of this porous cement mortar is shown in the illustrations. In

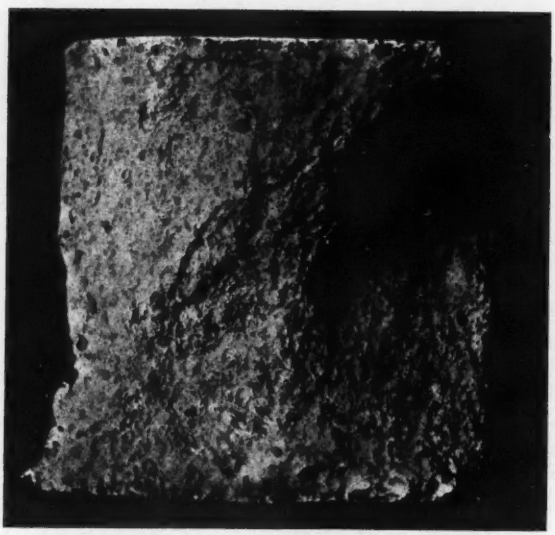


Fig. 1.—70 per cent. Cement, 30 per cent. Coke Ash, and 0.10 per cent. Aluminium Powder.

all the specimens 0.10 per cent. of powdered aluminium was used as a gas generator.

Zinc powder, mentioned in the American patent as a possible substitute for aluminium, showed results very much less satisfactory. In the most

favourable case, *i.e.*, without sand, the increase in volume amounted to only 30 to 50 per cent. and then only when the mixture was extraneously heated.

Much better results were obtained by the process proposed by the writer in conjunction with Dr. Killig, the basis of which has been mentioned in the first part of this paper. That the influence of calcium chloride is to increase the expansion appears from the fact that a mixture of 400 g. cement, 9 g. zinc powder, and 7.5 g. calcium chloride in solution produced large voids, while a mixture of 300 g. cement, 9 g. zinc powder, and 7.5 g. calcium chloride produced small voids. Calcium chloride possesses another advantage over aluminium in that the process ceases as soon as the action of chloride (which is to increase the temperature and hasten crystallization) has subsided, while, with aluminium, gas may continue to be evolved so long as unconsumed particles of the metal are present, even if this action is imperceptible. While the reaction is violent for only one or two hours, it continues under certain circumstances and materially affects the initial set and final hardening of the cement when aluminium is used.

Employing this process, the following results were obtained:—

Table 5.—Porous Cement Mortar with Zinc and Calcium Chloride.

Test No.	Zinc, per cent.	$Ca.Cl_2$ per cent.	Compressive strength at 28 days, lbs. per sq. in.
162	2.25	3.75	1,267
171	2.25	3.75	1,014
172	2.25	3.75	1,361
173	2.25	3.75	1,333
174	2.25	3.75	1,077
Average compression strength (*Nos* 162, 171-174), 1,196 *lbs. per sq. in.*			
285	2.50	6	1,196
286	2.50	7	591
287	2.50	8	422

Searching for other possible gas-forming chemicals, some of which are mentioned in the American letters patent, nothing was found that promised success. To increase the reaction between zinc and cement, a powder galvanised with copper was tried. The results were quite negative. Using aluminium carbide an expansion of 25 per cent. was obtained. With calcium carbide the cement expanded 20 per cent. The comparative failure of both these carbides is probably due to the fact that they react with the water, forming acetylene and methane respectively, while in the case of zinc and calcium chloride the lime of the cement furnishes the third component to the reaction.

When adding 50 per cent. of water a large part of it is used in hydrating the cement; only a small part remains for the formation of hydrogen gas. But to increase the water content was impracticable because the gas bubbles could rise through the slurry mixture as gas bubbles rise through liquids, and no expansion was possible. In the same way the action was too violent with sodium carbonate and with aluminium chloride to permit expansion of the cement, apart from the disagreeable smell of the aluminium chloride which

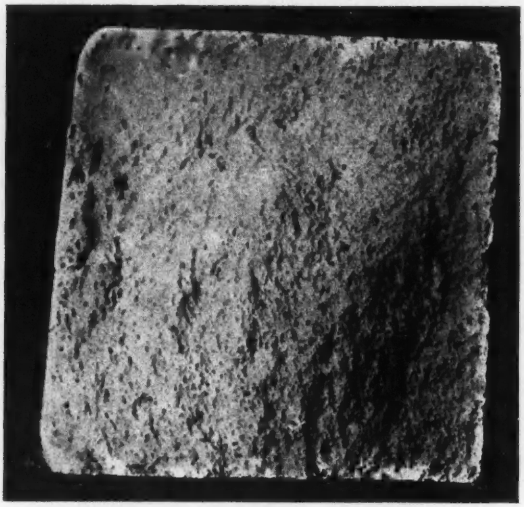


Fig. 2.—50 per cent. Cement, 50 per cent. Sand, and 0.10 per cent. Aluminium Powder.

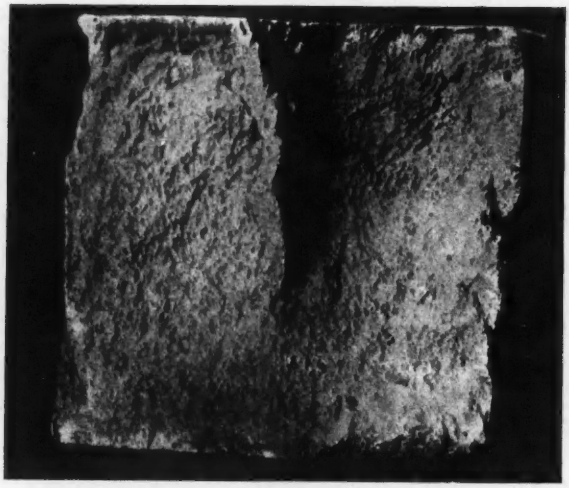


Fig. 3.—25 per cent. Cement, 75 per cent. Sand, and 0.10 per cent. Aluminium Powder.

alone would prohibit its use. A further attempt to use magnesium superoxide with an organic reducing agent, such as stearine, to generate oxygen gas failed completely. Zinc and caustic potash as well as chloride of iron and calcium carbonate, while they expanded the mortar slightly, did not nearly approach the effects attained with either powdered aluminium or the zinc and calcium chloride combination.

In all cases the initial set of the cement is disturbed by the action of the chemicals. Though it is claimed in the American patent that the gas-producing reaction ceases the moment the initial set begins, it must be remembered that setting begins as soon as cement comes in contact with water and not at the time when the imperfect Vicat needle apparatus records it; and in any case aluminium and zinc and calcium chloride react with the component parts of cement and change its chemical composition. These chemical changes and the less dense structure of the porous cement mortar compared with normal cement mortar probably explain why the strength of this kind of cement mortar diminishes in so high a degree.

Summary of Results.

(1) Two patented processes are reported on, U.S. Patent 1,087,098 and German Patent 327,097, by which it is proposed to swell cement mortar through the generation of hydrogen before the initial set takes place.

(2) Tests of the American process, using powdered aluminium as a gas producer, showed increases in volume up to 130 per cent. Compressive strengths were considerable when 25 to 50 per cent. of sand was used. The specific gravities varied between 0.75 and 1.2, depending on the sand content.

(3) Using the German process with zinc and calcium chloride, average compressive strengths of 1,196 lbs. per sq. in. were attained.

(4) Experiments with other gas-generating chemicals are reported, all of which, however, were shown to be less effective than those mentioned above.

An Acquisition by the Medusa Company.

The Medusa Portland Cement Company has acquired the Newaygo Portland Cement Company and its subsidiary, the Manitowac Portland Cement Company. The three companies will continue to conduct their separate affairs as heretofore.

Capital Increases in France.

Société Dordognaise des Chaux et Ciments de Saint-Astier (slag cement) is increasing its capital from Frs. 578,500 (£4,630) to Frs. 4,300,000 (£34,450).

Ciments de Marcoing, Lille, has increased its capital to Frs. 40,000,000 (£320,000).

Marking of Imported Cement.

In our August number we reported the inquiry held by the Standing Committee of the Board of Trade, under the Merchandise Marks Act, 1926, into the application of the Institution of Cement Manufacturers that imported Portland cement should bear an indication of origin at the time of sale and exposure for sale, and also at the time of importation.

The Committee has now issued its report, which recommends that all containers of imported Portland cement should be conspicuously marked with its country of origin.

The Report states, *inter alia*: "It is no doubt true that the larger purchasers, namely, the large contractors or builders, do not as a rule need the protection of an Order. In this connection it may be noted that the National Federation of Building Trades Employers claimed that members of their Federation (which, they stated, comprises more than ten thousand builders both large and small throughout the country), are aware of the origin of the cement which they buy. But even if this claim be fully admitted, it is difficult to believe that it is equally admissible with regard to the very numerous small jobbing builders, largely engaged on repair work, who are outside the organisation and who appear greatly to outnumber its members. In our opinion there is a substantial possibility that many of these consumers may not be aware of the origin of the Portland cement which they purchase.

"It was part of the opponents' case that a considerable proportion of imported cement already bears an indication of origin. We can see no hardship in requiring the remainder similarly to bear an indication of origin. We can see no valid ground for believing that such a requirement would prevent consumers from having recourse to foreign cement, if and when the price and quality of that cement make it advantageous to do so. We fail, therefore, to see how a Marking Order could lead to the raising of prices, or give the British manufacturers a monopoly of the home market.

"We are not prepared, however, to recommend the making of an Importation Order. There was some dispute between the parties as to whether so-called 'natural cement' is or is not properly described as 'Portland cement.' And, apart from this particular question, we are disposed to doubt whether Customs officers could be reasonably expected to distinguish between Portland cement and other cements not included in the application. We are of the opinion that an Importation Order is unnecessary in the present case, and that it might very well lead to difficulties at the ports and cause delay to trade.

"We recommend that the Order-in-Council should require any sack, bag, cask, or other container in which imported Portland cement is sold or exposed for sale to bear an indication of origin, printed or stamped, stencilled or painted, or branded in a conspicuous manner. Section 10 (4) (*b*) of the Merchandise Marks Act, 1926, provides that exposure for sale shall not include exposure for sale wholesale by a person being a wholesale dealer unless the Order expressly provides to the contrary. We see no reason for specifically requiring imported Portland cement to bear an indication of origin at the time of exposure for sale wholesale as distinct from wholesale sale."

It is recommended that the Order-in-Council should come into force three months after the date on which it is made.

New Plant for Damascus.

A German firm is reported to be arranging for the supply and erection of a cement plant for Damascus. This is the second plant mooted for Syria. Consumption of cement in Syria during the past three years has been as follows: 1926, 54,870 tons; 1927, 72,726 tons; 1928, 96,557 tons.

The Lubrication of Cement Mills.

In probably no other industry are the operating conditions more adverse to the satisfactory lubrication of machinery than in cement mills. Throughout the various processes the machines are subjected to heavy loads, and have necessarily to work in dust-laden surroundings, so that continuity of operation is made possible only by paying strict attention to the lubrication of all working parts. Care bestowed on the selection and correct application of suitable lubricants will manifest itself in reduced friction and wear, and consequently in the outlay for repairs and renewals.

Space considerations preclude detailed treatment of the subject in all its aspects, but it is possible to indicate in a general way the classes of lubricant that are necessary to obtain satisfactory running of cement machinery over prolonged periods of service, and the care that should be given to the various methods of application employed.

Steam Navvies.

Steam navvies perform rough, heavy and intermittent work in exposed surroundings—conditions that demand correct lubrication to ensure satisfactory operation.

Cylinders and Valves.—In many cases oil is supplied by means of dose cups or by hydrostatic lubricators; but, almost without exception, improved operation can be obtained by employing an efficient mechanical lubricator arranged to feed oil to an atomizer in the main steam pipe. The steam impinging on the atomizer breaks the oil up into small particles, which are carried in suspension in the steam and distributed evenly over the internal working surfaces. A mechanical lubricator such as the Delvac has the advantage of being capable of feeding the minimum quantity of oil required with regularity and precision, so that used in conjunction with a suitable oil of good quality distinct economies are possible.

In the lubrication of steam cylinders and valves one of the principal factors to be taken into account is the washing effect of the steam. This is particularly marked in steam navvies owing to the intermittent operation and the fact that the steam pipes are usually exposed. These conditions cause wet steam to pass into the cylinders, particularly in cold weather when the condensation in the steam pipes is more pronounced. A further difficulty is that of obtaining clean feed water for the boiler. Water has often to be drawn from sources containing impurities that tend to cause priming.

It is false economy to be guided by price alone, as an oil of inferior quality requires to be fed in excessive quantities to maintain an unbroken film, thereby leading to the formation of undesirable deposits. Failure to maintain an effective lubricating film will result in rapid wear and cause leakage of steam past the piston rings with consequent loss of power.

For the lubrication of the cylinders and valves the oil should be correctly compounded to enable it to form an adhesive film in the presence of water, and to resist the formation of gummy deposits when contaminated with impurities carried over with the steam from the boiler. It should be of the correct body to

withstand the operating pressures and temperatures encountered, and to prevent blow-past of the steam at the piston rings and valves.

Bearings.—Many of the bearings are arranged for grease lubrication and are equipped with screw-down grease cups. The cups should be kept filled with a suitable grease of the correct consistency and given a slight turn at regular intervals to keep the lubricant up to its work. Where oil is used application may be by siphon oilers or by hand. The former method is preferable, since the feed of oil to the rubbing surfaces is more regular and its rate can be adjusted by increasing or decreasing the number of strands in the worsted trimmings.

To obtain the best results from siphon oilers the trimmings must be kept as free from dust and dirt as possible. Therefore they should be cleaned periodically by soaking them in paraffin oil and drawing them between thumb and finger to remove impurities clinging to the worsted. Before replacing the trimmings they should be as free as possible from paraffin oil.

To withstand the severe duty imposed the oil used must be of relatively heavy body and possess the necessary lubricating properties to enable it to maintain an effective film over the rubbing surfaces. Where the machines are fitted with caterpillar tracks the rollers require special attention, otherwise the heavy pressures encountered will quickly cause excessive wear.

Gears.—These are subjected to intermittent heavy pressures and usually exposed to all manner of adverse conditions. Generally they are grease-lubricated by hand, and it is necessary to use a suitable grease of correct consistency that will form a strong adhesive film over the teeth to cushion them against shock and to protect them from excessive wear. It may be desirable in some cases to warm the lubricant before application to ensure even distribution over the gear teeth. In all cases the teeth should be clean and dry before the lubricant is applied.

Wire Ropes.—During manufacture wire ropes are impregnated thoroughly with a suitable oil, but their lubrication in service is frequently neglected to such an extent that the ropes become dry and wear badly. A wire rope has many wearing surfaces; hence the attention given to lubrication has a considerable influence upon its length of useful service. Various methods of applying the lubricant are employed, such as hand application, drawing the rope through a bath of oil, and leaving the rope submerged in oil for a definite period.

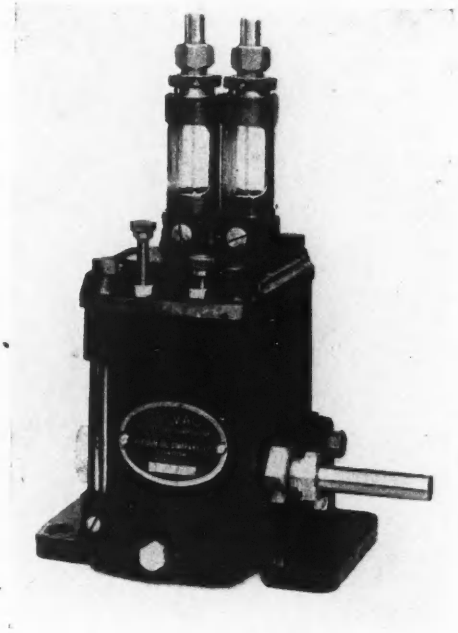
To be suitable for wire ropes the lubricant must be entirely free from acid or alkali and impervious to moisture. It should penetrate readily between the outer strands. Where heavy-bodied oils are used they should be heated before application to assist penetration. Poor quality oils and waste oils should never be used on wire ropes, as they do not cling to the surface or resist the effect of water; moreover they are always liable to contain harmful impurities.

Crushers.

Crushers operate always in dusty and dirty surroundings and are subjected to heavy shock loads. It is necessary therefore to ensure that all the rubbing surfaces are protected by a complete lubricating film.

Gyratory Crushers.

Eccentric Bearings.—These bearings are subjected to very heavy fluctuating pressures, thereby producing severe shock loads that tend to rupture the oil film. Realising the importance of correct lubrication, the builders of gyratory crushers arrange for the eccentric bearings to be lubricated by oil-bath or force-feed circulation. In both these methods of application the oil is subjected to continued use, and it is essential to use a suitable high-grade oil that will retain its lubricating properties over prolonged periods. Every care must



Mechanical Lubricator.

be taken to prevent, so far as is possible, the ingress of dust, grit and other impurities to the oiling system. Oil reservoirs should be drained at regular intervals and cleaned thoroughly before replenishing them with fresh oil. With a suitable high quality oil in use the oil recovered at times of cleaning may be filtered and used again repeatedly, thus permitting of considerable economy in working costs.

Suspension Bearings.—The loads on these bearings are comparatively light and, provided a suitable lubricant be applied regularly, no difficulty should be experienced in their operation. Lubrication is sometimes effected by hand-oiling, or the bearings may be grease-packed.

Countershaft Bearings.—These are lubricated usually by screw-down grease cups, siphon oilers or ring-oilers. To obtain the best results from ring-oilers it is necessary to pay strict attention to the cleanliness of the oil in service, and to the maintenance of the correct oil level in the reservoirs. As the oil is in repeated use it is essential that it shall possess, in addition to correct body, good lasting properties that will permit of periodic treatment when the reservoirs are emptied and cleaned, and the ability to separate readily from impurities that unavoidably gain access to the reservoirs.

Bevel Gears.—In order to cushion the teeth against the heavy shock loads encountered, and to protect them effectively against excessive wear, the bevel gears of gyratory crushers usually operate in an oil-bath. Oil escaping from the eccentric bearing forms a shallow bath into which the bevel wheel dips and distributes the oil over the gear teeth. Therefore, when selecting an oil for the eccentric bearing, it is important to give consideration to the requirements of the gears.

Jaw Crushers.

To secure maximum output from these machines it is important to pay regular attention to the lubrication of the Pitman bearings, the swing jaw bearings and the toggle joints.

Pitman Bearings.—From a lubricating standpoint these bearings are of the utmost importance, being subjected to severe intermittent shock loads. Several methods of applying the lubricant are employed, according to whether grease or oil is used. Some Pitman bearings are fitted with screw-down grease cups, whilst others are packed with grease. Where the latter method of application is employed it is good practice to line the cavity in the bearing cap with a suitable wool sponge grease before filling with lubricating grease. In this way the supply of grease to the bearing surfaces is controlled over a fairly wide range of temperatures, and the ingress of dust and grit reduced to the minimum.

The manner in which the wool sponge grease is packed in the bearing cavity is important. It should be worked into an endless ring of suitable size and laid carefully inside the bearing cap. Special care should be taken to work any loose ends of yarn into the grease, as if any of the strands be drawn into the bearing there will be danger of the whole of the packing being displaced. Provided the bearings be packed correctly they should run for about six months without much attention beyond replenishing the centre of the cavity from time to time with fresh grease.

Where these bearings are arranged for oil lubrication they may be designed to operate in an oil-bath; or oil may be fed through sight-feed drop oilers or siphon oilers. In some cases the cavity in the bearing cap may be filled with wool waste saturated with oil, replenishment being effected by hand.

Owing to the difficulty of lubricating Pitman bearings effectively, mechanical lubricators have been adopted with marked success, notably the Delvac mechanical lubricator, which feeds oil to the bearings through flexible pipes and, being actuated by the machine itself, supplies oil only when the machine is in motion, thereby eliminating waste. Whatever method of application be em-

ployed, it is essential to use only a good quality lubricant that will form and maintain a strong lubricating film over the bearing surfaces and withstand the severe loads encountered.

Swing-Jaw Shaft Bearings.—Although the loads on these bearings are not so severe as those on the Pitman bearings, regular attention should be given to their lubrication. Grease lubrication is the most common practice, although in some cases oil may be used, the methods of application being similar to those employed for Pitman bearings.

Toggle Joints.—Owing to the unavoidable presence of excessive quantities of dust and grit, and the difficulty of applying the lubricant effectively, the satisfactory lubrication of these parts presents a complex problem. When assembling the toggles the joints should be greased thoroughly. They should be oiled regularly before starting up a machine. With a view to securing improved lubrication, it is a good plan, where practicable, to place cotton waste saturated with oil across the ends of the toggles. This will assist in preventing dust and grit working into the grooves, and oil poured on to the waste will percolate to the bearing surfaces in as clean condition as is possible.

Roll Crushers.

The only parts of these machines requiring lubrication are the roll bearings and the gears. The roll bearings may be lubricated either by grease applied through screw-down grease cups, or by oil, which is fed usually to a pad of wool waste packed in the cavity of the bearing housing. This pad should be kept well saturated with a suitable oil. In selecting suitable lubricants for the roll bearings, low speeds and heavy pressures are the factors that require consideration, and if friction and wear are to be reduced to the minimum it is essential in all cases to use lubricants of good quality.

Where one roll is driven from the other through spur gears, the lubrication of the gear teeth must be given careful attention. As the gears are exposed to dust and grit, the lubricant employed must form a strong protective coating over the tooth surfaces. Provided the teeth are clean and dry before applying the lubricant good results will be obtained from a suitable grease or very viscous oil applied by hand at regular intervals. To ensure even distribution over the gear teeth and to avoid waste it may be advisable to heat the lubricant before application.

Wash-mills and Slurry Mixers.

The bearings of these machines are equipped usually with screw-down grease cups, which should be given regular attention. The gears should be kept well coated with a good quality grease of the correct consistency that will form and maintain a durable film over the tooth surfaces.

Ball and Tube Mills.

Trunnion Bearings.—Usually these are of plain type arranged for grease lubrication, a large cavity being formed in the bearing cap to hold a quantity of grease in contact with the journal. It is good practice to line the cavity with a suitable wool sponge grease before filling with lubricating grease. The

correct method of packing bearings of this class has already been referred to in connection with the Pitman bearings of swing jaw crushers. Where oil lubrication is preferred the cavity in the bearing cap may be filled with wool waste saturated with oil. In all cases the bearings should be provided with dust-proof covers, which should be kept closed.

Grinding is accompanied by the generation of considerable heat, which is conducted to the bearings and leads to comparatively high operating temperatures. The bearings are subjected also to heavy loads and rotate at low speeds. Therefore, whether grease or oil be employed, it is essential to use only high quality lubricants possessing good lubricating properties to ensure the formation and maintenance of a complete lubricating film between the rubbing surfaces.

Countershaft Bearings.—These bearings may be lubricated by means of ring oilers, siphon oilers, or screw-down grease cups. The care that should be taken to ensure satisfactory lubrication where these methods of application are in use has already been outlined.

Gears.—Generally the gears driving ball and tube mills are of open type, and are therefore exposed to dust and grit which tend to cause rapid wear and abrasion of the gear teeth. As a result, lubrication is both important and difficult. It is essential to apply at regular intervals a lubricant possessing marked adhesive properties and of such a character that it will not peel or be thrown off the teeth. Before applying the lubricant the teeth should be clean and dry. It may be necessary to heat the lubricant before application to ensure even distribution over the tooth surfaces.

In some cases a drive is taken direct to the hollow trunnion, the gears being enclosed in an oil-tight casing. Under such conditions the detrimental effects of dust and grit are avoided to a large extent, and the lubrication of the gears becomes a simpler problem. It is important to maintain the correct oil level in the reservoirs. Too high a level will cause undue churning, thereby shortening the useful life of the oil and leading to high operating temperatures. If the level be too low insufficient oil will be carried to the gear teeth, resulting in metallic contact and wear.

Oil-baths should be drained at regular intervals and cleaned thoroughly before replenishing them with new oil. Provided a suitable high quality oil be in use the oil recovered at times of cleaning may be filtered for further service. To be suitable for the lubrication of enclosed gears the oil must be of the correct body and character to follow and coat the teeth, to cushion them against shock, and to prevent undue wear. It must be capable of separating readily from any impurities with which it may become contaminated, and should retain its lubricating properties over prolonged periods.

Rotary Kilns and Coolers.

Bearings.—The bearings, particularly those of the track rollers of rotary kilns, are subjected to high temperatures resulting from the heat conducted from the kilns, and in some cases it has been found necessary to arrange for

water-cooling. Furthermore the loads encountered are heavy, speeds are low, and grit and dust are unavoidably present. Under such conditions, unless regular attention be given to lubrication, excessive friction and wear will take place. Almost without exception, the bearings are arranged for grease lubrication, the grease forming a fillet around the bearing ends and so preventing the ingress of dust and grit to the rubbing surfaces. Only a high-grade grease of the correct consistency can be relied upon to give satisfactory results. The bearings are usually equipped with screw-down grease cups, which should be given a slight turn at regular intervals to keep the lubricant up to its work.

Gears.—Apart from the higher working temperatures the lubricating requirements of the driving gears of rotary kilns and coolers are similar in all respects to those of the open-type gears of ball and tube mills. The regular application of a suitable high-grade lubricant will give smooth running and increase the useful life of the gears.

Coal Crushers.

Coal crushers are subjected to heavy loads and relatively high temperatures, and operate under adverse conditions. Usually the bearings are grease-lubricated, application being effected through screw-down grease cups. Only a suitable good quality grease of correct consistency and regular attention to its correct application will maintain the reliability and useful life of these machines.

Electric Motors and Fans.

The bearings of this high-speed equipment may be of plain type or ball or roller type, the former being fitted usually with ring-oilers and the latter with screw-down grease cups. Where ring-oiled bearings are fitted, it is important to take every precaution to prevent the ingress of dust and grit to the oil-wells and the correct oil level must be maintained. Only a suitable high quality oil of relatively light body should be used. In the case of ball or roller bearings the grease cups should be given a slight turn at regular intervals as required. If several turns be given at irregular intervals the grease may be packed too tightly in the housings, thereby introducing rather than eliminating friction. Absolute purity of the grease is essential. It should be commercially acidless, and entirely free from any filling or loading material of a solid nature.

Conclusion.

The wide divergence of the operating conditions found in different cement mills makes it impossible to lay down specific recommendations of suitable lubricants to meet all requirements. Mill owners are, therefore, well advised to avail themselves of the technical assistance of lubricating specialists, so that advice may be given in the selection and correct application of suitable lubricants. (These notes have been specially written for " Cement and Cement Manufacture " by the Technical Department of the Vacuum Oil Company, Ltd.)

IMPORTS AND EXPORTS OF CALCAREOUS CEMENT FOR SEPTEMBER 1929 AND THE PERIOD JANUARY 1 TO SEPTEMBER 30, 1929.

Imports.

—	QUANTITIES IN TONS.						VALUE IN £.					
	MONTH OF SEPTEMBER.			JANUARY 1 TO SEPTEMBER 30.			MONTH OF SEPTEMBER.			JANUARY 1 TO SEPTEMBER 30.		
	1927.	1928.	1929.	1927.	1928.	1929.	1927.	1928.	1929.	1927.	1928.	1929.
	35,567	19,230	25,555	331,707	223,640	216,009	72,058	37,169	45,196	691,649	424,771	398,166

Exports.

To Netherlands	346	1,200	1,773	471	7,625	20,456	702	1,747	2,850	1,243	12,234	37,186
„ Brazil	4,169	7,656	6,332	28,291	41,743	49,855	9,956	15,800	12,449	68,698	93,396	103,263
„ Argentine Republic ...	1,558	51	296	18,878	24,272	62,254	3,924	146	548	45,430	55,249	129,041
„ Irish Free State ...	9,779	9,398	10,191	81,802	95,333	105,221	30,462	29,637	29,612	265,162	295,592	309,027
„ British West Africa ...	6,365	9,464	6,640	71,310	94,422	63,327	17,247	23,295	16,551	182,661	239,157	156,907
„ „ South Africa	425	178	319	4,436	3,144	3,247	1,371	554	1,147	12,804	10,433	9,921
„ „ India... ...	11,618	11,675	9,266	85,909	72,056	71,831	29,794	31,644	25,083	227,260	185,998	187,099
„ Straits Settlements and Malay States	3,543	13,289	8,013	36,345	81,254	69,124	8,745	32,611	19,126	97,363	199,049	167,389
„ Australia	2,697	1,981	813	13,201	16,193	11,677	7,619	5,914	2,206	38,821	44,297	31,880
„ Other Countries ...	23,142	34,992	34,242	201,830	238,245	357,888	57,394	78,248	68,478	525,892	561,770	760,375
Total	63,642	89,924	77,885	542,473	674,287	814,880	167,214	219,596	178,050	1,465,334	1,697,175	1,892,088

Conference of German Portland Cement Manufacturers.

THE annual meeting of the Association of German Portland Cement Manufacturers was held on September 2-4, and in the following we give abstracts of the more important papers read:

The meeting opened with a strong protest against a recent Government decree permitting the use of natural cement for concrete for building purposes, in individual cases, at the discretion of the Government building authorities provided that the natural cement passed the tests of the Portland cement specification.

Effect of Fineness and Chemical Composition on the Amount of Water Required for Mixing Cement.

Professor H. Kühl reported on a series of tests made of 24 cements, obtained by grinding each of four clinkers, of different composition, to six degrees of fineness. Each of the 24 cements was gauged moist, plastic, and fluid. All the cements were slow setting at normal fineness. In two cases the setting-time was reduced by fine grinding, and in one instance the set became almost instantaneous. It was found that for all four cements the amount of mixing water required increased with fineness of grinding, and, generally speaking, the clinkers which were difficult to grind required more water than those more easily ground.

Professor Kühl said the highest strength was generally obtained with cement of medium fineness, *i.e.* the strength decreased if grinding was carried too far. Maximum strength moved in the direction of coarser grinding as the amount of water used was increased. This conclusion was of great practical importance, since it had hitherto been accepted that fine cement was better adapted to wet mortar than coarse. Variation of the water content resulted in differences in strength up to 50 per cent. These differences were least in the case of medium fineness, and greatest with very fine cements. The water required for normal consistency increased almost proportionally to fineness, and was independent of chemical composition. It was a fallacy that the best properties of a cement were brought out by very fine grinding: they resulted rather from correct grading. It was concluded that Feret's formula for calculating the strength of cement at a later date from the results of earlier tests, when plastic or wet mortars had been used, was invalid.

Testing of Plastic Mortars.

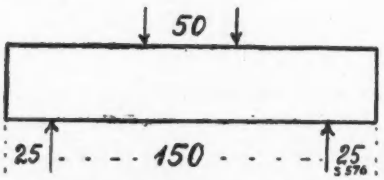
Dr. Haegermann stated that the International Association for Testing Materials had recently worked upon developing a new method of testing plastic mortars, using a prismatic test-piece which was submitted to a bending test. This method had, however, been adversely criticised. For various reasons the Materialprüfungsamt, Berlin, had given up the use of plastic mortars for testing.

The laboratory of the German Portland Cement Manufacturers' Association had also worked on this problem, and had come to the conclusion that a sand of a single grain-size was unsuitable for testing plastic mortars. Experiment led to the use of two grain sizes (1) 1.02—1.5 mm., and (2) 0.15—0.3 mm. Four parts of the coarse material were mixed with one part of the fine. The process of gauging was as follows: The sand was stirred for one minute, after which the cement was added. After a further one minute's stirring the water was added, and the stirring was then continued for two minutes. A mixing machine had been designed for this process.

For the determination of normal consistency a flow-table had been designed with standard dimensions. A Burchartz funnel of 6 cm. diameter, also standardised, was used. The prismatic moulds consisted of three pieces. The mould was half filled, tamped, and then filled up. The tamper was also standardised. The prism was 20 cm. long, and it was considered desirable to apply the pressure at two points, instead of at one as previously.

The application of the pressure is made clear in the illustration overleaf.

A final opinion as to the value of the



Application of Pressure to the Prism in Bending. (Dimensions in mm.)

method could not yet be given, but results would be published later.

Recent Researches.

In a paper on " Recent Researches " Prof. Nacken dealt with two of his recent investigations:

(1) Light-coloured crystals were observed in a clinker from high-grade limestone and Santorin earth. The crystals, on separation, rapidly reverted to the usual colour of clinker. Analysis of the crystals gave the composition $CaO.Al_2O_3.SiO_2$. The crystallographic constants were those of the mineral velardenite of the same composition.

(2) Further light on the setting of cement was sought by (*a*) experiments on the solubility of cement in water, (*b*) determination of the thermal reaction on bringing water and cement together, and (*c*) determination of the chemically combined water at various stages during setting. It was found, said Dr. Nacken, that the solubility of $Ca(OH)_2$ or of gypsum in water was much increased by the presence of cement. In the case of $Ca(OH)_2$ this was due to the formation of a protective colloid, and in the case of gypsum to the presence of the hemihydrate; in the latter case the grain-size also influenced solubility. The thermal curves showed that the evolution of heat was more rapid in the case of cement free from gypsum than with gypsumised cement; the form of the two curves was, however, the same. The combined water was determined by allowing small test-pieces to set for definite periods and then heating for 1 hour at 110 deg. C. The water not driven off was assumed to be chemically combined. Both thermal curves and curves of combined water showed an initial strong reaction, followed first by a period of quiescence and later by a second well-defined reaction. The first reaction was accompanied by the formation of large quantities of $Ca(OH)_2$, and it might be assumed that it consisted of the vigorous decomposition of the high calcium silicates. The second reaction was of a colloidal nature. The effect of gypsum on setting time was due to its retardation of both the above reactions, partly by the action of the SO_4-ions in solution, but partly also owing to the action of the water vapour set free by the heat evolved during grinding with gypsum. The effects of various additions to cement were also studied by the above methods.

Coal Mills and Coal Grinding.

Professor Rosin gave a comparison of coal-grinding practice in the cement industry and in power installations. The developments in these two industries had, he said, been in different directions. The cement industry had aimed at reliability, so that no reserve of powdered fuel need be stored. The tube-mill had proved most satisfactory from this point of view, and had therefore been investigated and improved almost to the exclusion of research in other directions. Progress in grinding coal for power plants had taken the direction of the development of large mills of various types. Air was extensively used for separation and conveyance of the coal dust. The use of separate driers had been avoided by heating the air passing through the mill. Another development was the replacement of central grinding installations by small mills feeding the separate furnaces. The tendency of the present day was to reduce the fineness of the fuel and to regulate the conditions of burning to give satisfactory combustion of the coarser meal. The author suggested that the two industries might learn valuable lessons from each other.

New Wet Process Works in the United States.

This paper, by H. Engel, gave an account of a visit to the United States. Of 26 recently built works in that country, it was stated, 24 were working the wet process. The most striking innovations were the transport of unpacked cement, the large number of waste-heat boilers, and two experimental plants for filtration of the raw material slurry.

Setting of Portland Cement.

Prof. F. Krauss gave a preliminary account of an investigation consisting of the determination of dehydration isobars at 7 mm. pressure and examination of the solid phases by X-ray analysis, etc. As a preliminary to the main investigation, the isobars of gypsum and calcium carbonate were first determined. In the latter case the existence of the hexa- and monohydrates was established, and the hexahydrate was for the first time obtained pure.

The investigation of cement, the author said, was complicated, and the interpretation of the results could not yet be accurately given. Melts of various compositions were prepared, ground, and set with water, and the dehydration isobars of the products determined. A melt of the composition tricalcium silicate showed dehydration steps at 25 deg., 100 deg., and 375 deg. C., the dehydration being almost complete. The 375-deg. step corresponded to the dehydration of $Ca(OH)_2$. The existence of a new compound also appeared to be indicated. With a melt of composition tricalcium aluminate, the $Ca(OH)_2$ step scarcely showed. A very pronounced step at 200 deg. C. was observed, in part due to $Al(OH)_3$, but whose magnitude could yet be explained. With a melt of composition 8 CaO. 2 SiO_2. Al_2O_3 was observed a marked step at 15 deg. C., also not yet explained. The step at 200 deg. C. hardly appeared.

With set cement, free from gypsum, were observed the 25 deg. and 375 deg. C. steps. With set gypsumised cement were found dehydration steps at 35 deg., 50 deg., 75 deg., and 100 deg. C., above which the curve had a zeolithic form until the 375 deg. C. step was reached. The first step in this case, 35 deg. C., probably corresponded to the 25 deg. C. step mentioned earlier. The higher temperature might be due to greater strength of the crystal lattice resulting from longer storage.

Comparison of the various curves showed a definite similarity between the composition of the cement and the melt 8 CaO. 2 SiO_2. Al_2O_3.

Chemo-dynamic Phenomena in Cement.

H. Luftschitz stated that the adhesion of iron to concrete was due to internal pressure resulting from the shrinking and swelling of the cement. He distinguished between the force of diffusion, which forced salts to the surface, and the force setting up internal pressure. The difference in the amounts of efflorescent salts when cement was stored in water (*a*) immediately after gauging, and (*b*) at initial set, was determined; the amount in case (*a*) was found to be about double that in case (*b*). The amount of this efflorescence might be assumed to be parallel to the force of diffusion through the cement gel. Practical conclusions from these experiments were: (*a*) that high-strength and blast-furnace cements were much richer in gel than ordinary Portland, and (*b*) that the use of wet concrete might result in appreciable, but not necessarily important, loss in strength.

The internal force set up in cement on setting was measured by embedding water-filled rubber bags in gauged cement, the bag being connected to a capillary tube and the height of the water column measuring the pressure. The thermal expansion due to the exothermic reaction of setting cement was allowed for. Curves of increasing pressure with time were plotted, which showed breaks at initial set and after 24 hours. These experiments showed that the pores of the cement mass continuously shrunk, the expressed water forcing its way through the surrounding gel with increasing difficulty.

Crystallisation Forces in Set Portland Cement.

In this paper the author (C. Prüssing) described experiments disproving Gensbaur's claim that, using combined water-air storage of test-pieces (Kl-storage), the reduction in tensile strength consequent upon a final 28 days in water formed a measure of soundness. The author stated that every change in conditions of storage disturbed the equilibrium of the test-piece and set up internal stresses; whether these became observable or not depended upon the density of the mass. The stresses were due to alteration of the physical conditions at the surfaces of individual crystals, as affected by change in water concentration. A linear relation with the composition of the cement did not hold, and the change in strength resulting from the internal stresses could have no relation to soundness.

Kiln Linings.

In the case of a kiln lining of short life, A. Müller said the clinker and flue dust showed a much higher Al_2O_3 content than could be explained by the addition of coal ash. The rapid deterioration of the lining was found to set in when small additions of fluor-spar were added to the raw slurry. Analyses showed that the Al_2O_3 content of the firebrick and of the fused coating had been considerably reduced, while important amounts of fluorine and alkalies had been absorbed; this was particularly the case immediately behind the clinkering zone. A sample of the fused coating was found to contain 0.73 per cent. CaF_2 and 1.13 per cent. Na_2O+K_2O. There was thus in the lining an exchange of Al_2O_3 for fluor-spar and alkalis, to which its short life was due. Great care was therefore required when fluorspar was added to the raw slurry.

Notes from Abroad.

Brazilian Plant Extensions.

The following is an extract from the President's report at the recent meeting of the Canadian Foreign Investment Corporation: " During the early part of 1928 the profits earned by the Brazilian cement plant were disappointing, those in the first four months being barely sufficient to meet interest charges on the mortgage and the advances; but from May onwards results showed great improvement, and the profit for the year amounted to about $170,000 after payment of the interest charges on the mortgage and other advances. At the beginning of the present year several large orders were received, the unfilled orders at the end of January being over 290,000 barrels. In view of this, machinery and equipment have been ordered and the necessary construction work is now under way for an additional capacity of 1,300 barrels per day. While the capacity of the present plant is not as great as we estimated, being from 600,000 to 650,000 barrels per year, with the additional unit our capacity should be approximately 1,000,000 barrels per annum."

New Cement Laboratory in the United States.

The U.S. Bureau of Standards has set up a laboratory for the testing of Portland cement, the calibration of machines and instruments used in cement testing, and for the training of men for commercial cement testing laboratories. The laboratory is jointly supported by the American Society for Testing Materials and the Federal Government.

State Factory for Uruguay.

The National Administrative Council has approved the establishment of a State cement factory. The project has not yet received the sanction of the Chamber.

Prices in France.

The prices of artificial Portland cement delivered in store in Paris (octroi not included) were increased on July 2 from 260 frs. per ton to 285 frs.

Abstracts from the Foreign Press.

Comparative Tests of High-Strength Cements. Anon. *Rev. Matériaux de Construction*, july, p. 254, 1929.

Comparative tests of five brands of rapid-hardening Portland cement and of a sample of aluminous cement were carried out by " L'Union technique du Bâtiment et de Travaux publics." The rapid-hardening cements on the market are very susceptible to atmospheric moisture, and air setting may have a considerable effect on the strength at two days. In the case of the cement that showed this effect most strongly, the storage of a sack of cement in the air of a room for 28 days reduced the crushing strength of 1 : 3 concrete at two days to one-third the value when fresh cement was used. In all cases, however, the 7-day and 14-day strengths were at least equal to those obtained using fresh cement. It is concluded that care must be taken if shuttering is to be removed after 24 or 48 hours, but that at 7 days there is nothing to fear.

It was also found that concrete made with rapid-hardening Portland cement is very susceptible to temperature variations during the first 48 hours.

The effect of different quantities of mixing water was studied on a 1 : 2 : 4 concrete. For the rapid-hardening cements, average crushing strengths at 7 days were : 60 per cent. water (on weight of cement), 247 lb. per sq. in. ; 70 per cent. water, 215 lb. ; and 80 per cent. water, 172 lb. per sq. in. The increase in strength from 7 days to 3 months was about 70 lb. per sq. in., whatever the percentage of mixing water.

In all cases aluminous cement gave results superior to rapid-hardening Portland cements, but its greater cost will always limit its use to special work.

" Sickness " of Certain Concretes of Aluminous Cement. R. Feret. *Génie Civil*, Vol. 92, p. 210, 1928.

In 1927, Freyssinet and Coyne reported occasional cases of loss of strength and abnormal brown coloration in aluminous cement concrete, and expressed the opinion that this was due to the use of materials strongly heated by the sun, conjointly with the use of sea water for mixing. The present author, after an extensive series of tests, has failed to find any sign of this " sickness " due to high temperature during mixing and hardening or to the use of sea water for mixing. On the other hand, his experiments indicate that the " sickness " is due to the addition of too much mixing water. He points out the importance of avoiding too fluid a consistency on the one hand and the use of aggregate containing too much fine material on the other.

Estimation of the Finest Fraction in Cement. H. W. Conell. *Tonind. Zeit.*, Vol. 53, p. 1105, 1929.

Air elutriation is greatly to be preferred to liquid elutriation for estimating the finest fractions in cement. In liquid elutriation the variation of internal friction of the liquid with temperature has a decided effect on the results unless the analysis is carried out at constant temperature. Using air, the effect of internal friction is negligible. Liquid elutriation will not analyse the fraction of diameter 30μ and under (of which Portland cement contains 50-60 per cent.).

Air elutriation will fractionate to 10μ and even to 5μ. Air elutriation is well adapted to extending a screen analysis. Other advantages of air elutriation are (1) the resulting fractions can readily be weighed; (2) a given coarse fraction can readily be further analysed; (3) the completeness of a separation can readily be tested by microscopic examination of the residue; (4) the method can be used by unskilled labour and requires only slight supervision. The author's air elutriation apparatus, developed at the Materialprüfungsamt, Berlin, and described earlier in 1929, is recommended.

Storage of Portland Cement. ANON. *Tonind. Zeit.*, Vol. 53, p. 946, 1929.

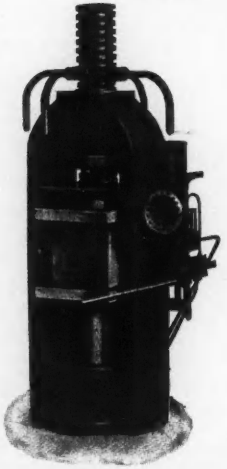
A résumé of the various results published during the past few years on the deterioration of Portland cement due to storage in sacks. The effect on both strength and setting time is dealt with, and the influence of the chemical composition of the cement is discussed.

Russian Developments.

In regard to the increased cement production programme of the Russian Government, as previously reported in this journal, we understand that a party of American industrialists has recently visited Russia with a view to discussing the question of the supply of machinery. We also understand that a German company is supplying machinery for the cement factory "Suchoi Log."

ALFRED J. AMSLER & Co.

SCHAFFHOUSE, SWITZERLAND.



Amsler testing machines are installed in some of the most important research laboratories in Great Britain.

THEY EXCEL IN ACCURACY, EASE OF OPERATION AND LONGEVITY.

The illustration shows a 500 tons Compression Machine which will take in up to 20" concrete cubes. Other sizes of the same design are of 50, 100, 200 and 300 tons capacity.

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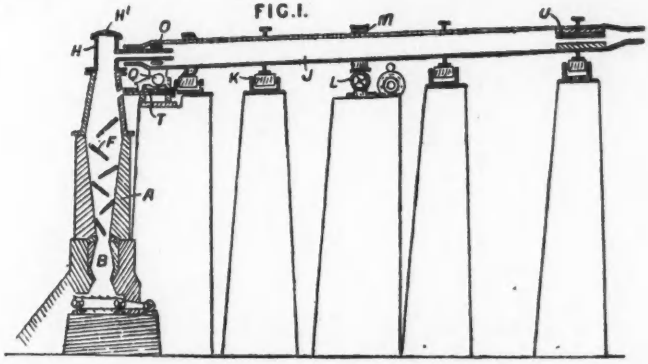
Recent Patents Relating to Cement.

Electric Kilns. BENHAM, H. J., 28, Norham Road, Whitley Bay. May 19, 1928, No. 14728.

A kiln for the manufacture of cement or lime comprises a shaft (*a*) provided with a plurality of baffle plates (*f*) and situated above a fusing chamber (*b*) fitted with electrodes, and a pulveriser (*q*) communicating with the shaft (*a*) and a preheating tube (*j*) into one end of which the raw material is fed. The waste gases pass up through the shaft and a T-shaped casting (*h*) into the preheating tube which is mounted on roller bearings (*k*) and rotated through a motor-driven worm gear (*l*, *m*). The casting (*h*) is fitted with an inspection door (h^1), or a pipe can be attached to lead the waste gases away from the shaft. The raw material passes into the pulveriser through slots (*o*) in the tube (*j*) and is fed into the shaft by a worm (*t*). The baffle plates (*f*) are adjustable. Projecting plates (*v*) are fitted at the charging end of the tube (*j*).

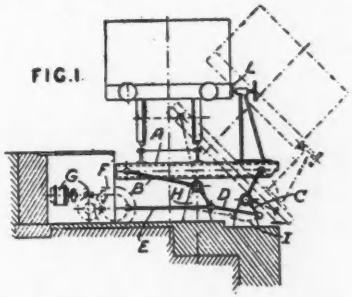
FIG. I.



Wagon-tipping Apparatus. TACVORIAN, H., 60, Grande Rue, Enghien-les-Bains, Seine-et-Oise, France. June 6, 1929, No. 17336.

A tipping-platform (*a*) with rails in line with the permanent-way is carried by sets of levers (*b*, *c*) pivoted on brackets (*h*, *i*), and arranged so that when the levers are rocked for tipping the wagon, the centre of gravity of the moving parts, including the loaded wagon or wagons, moves approximately in a horizontal line and little power is required to effect the tipping. The levers (*b*, *c*) are connected by links (*d*) and operated by a motor, etc., through reducing gearing, crank discs (*f*) and connecting rods (*e*). The wagon is held by hand-actuated clamps (*l*). As shown, the wagon discharges through side doors, but the tippler may be arranged for discharging the wagon through end doors with vertical or horizontal hinges.

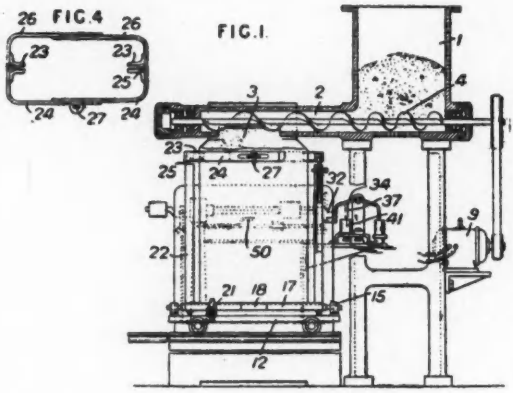
FIG. I.

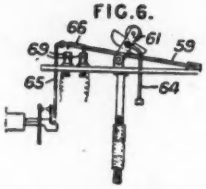


Weighing and Sacking Apparatus. JARRIER, R., 2, Rue de la Nef-d'Or, St. Quentin, Aisne, France. May 10, 1928. No. 13729.

A machine for simultaneously sacking and weighing granular or powdered material comprises a truck carrying a sack-holder and adapted to be pushed on to the platform of a weighing-machine, and a filling device

that is stopped when a sack on the truck contains a predetermined weight of material. The filling device comprises a feed hopper (1, Fig. 1), from which material is fed along a tube (2) into a sack (3) by means of conveyor worm (4) driven by a motor (9). The pitch of the worm (4) increases in the direction of feed to prevent clogging. Operation of a slidable starting handle (50) removes a pivoted strut from beneath the weigh-beam (32). The consequent downward movement of the beam effecting a quick break of the motor circuit. The sack is gripped by two pairs of jaws (23), Figs. 1 and 4, formed by members (24, 26) supported on vertical rods (25), the members (26) being fixed to the rods while the members (24) are pivoted thereto. The jaws are faced with rubber and are held closed by a pin (27). The rods (25) are adjustably supported within the upper ends of a pair of trestles (22) carried by a platform (17) that is pivotally mounted in bearings (15) disposed to one side of a wheeled



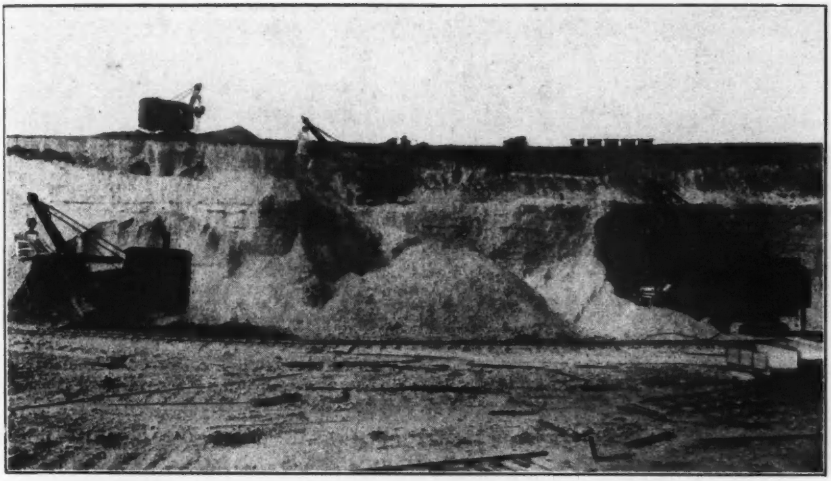


causes a contact (37) on a counter-weighted lever (34) to enter a mercury cup (41) and start the feed motor (9). When the required weight of material has entered the sack, the weigh-beam rises and the motor circuit is broken. In a modification (Fig. 6), the switch-lever (34) is replaced by a lever (59) having a pair of connected contacts (66) for insertion into mercury cups (69) in the motor circuit. To start the motor a pivoted counterweight (61) is rocked by a handle (64) to move the lever (59) into horizontal position. As the weigh-beam rises it contacts with an extension (65) of the lever (59), causing the weight (61) to rock and thereby truck (12). Depression of a pedal (21) allows the platform (17) to tilt under the weight of the sack so that upon release the sack drops clear of the truck. A counterweight (18) returns the platform to normal position. The members (26) are slidably connected, and one trestle (22) is slidably mounted to allow the distance between the jaws (23) to be adjusted.

[The foregoing are taken from "The Illustrated Official Journal" (Patents) by permission of H.M. Stationery Office. Copies of full Specifications may be obtained from the Patent Office, 25, Southampton Buildings, W.C.2, price 1s. each.]

RUSTON

Cement Excavators



This illustration is unique as it is seldom so many different types of excavators are seen working so close together. The machines are fitted with three different motive powers, i.e., Oil, Steam and Electric, and are working at the Northfleet works of the Associated Portland Cement Manufacturers.

The "Ruston" Excavator seen on the surface is oil engine driven, mounted on caterpillar tracks. The centre machine is an old type "Ruston" No. 12, steam driven crane navvy, which has been working for over 20 years. The lower machine, seen in the left hand bottom corner, is a "Ruston" No. 20 steam driven shovel, mounted on rail wheels. This also has worked continuously for 12 years. A latest type "Ruston" electrically operated shovel, with a bucket capacity of 3½ cubic yards, is seen in the bottom right hand corner.

If you are interested in Economical Excavating, send immediately for Catalogue illustrating our full range of Excavating Machinery:—Shovels, Draglines, Grabbing Cranes from 14 to 350 tons, ½ to 10 cubic yard bucket capacity. Steam, Oil, Electric, Oil-Electric or Petrol-Paraffin Driven.

Ruston & Hornsby Ltd., Lincoln.

Makers of Excavators for over 50 years.

Trade Notices.

Pumping Machinery.—We have received from Messrs. Ruston & Hornsby, Ltd., of Lincoln, a pamphlet entitled " Water Control by Pumping," in which information is given about the classes of pumps suitable for use in water supply, land drainage, irrigation, protection against fires and floods, and pumping chemicals and trade liquids, such as cyanide solution, paper pulp, naphtha, beet juice, vegetable oils, etc. Tables are provided showing the approximate cost of pumping per thousand gallons of water against different heads and at various rates, the velocities of water at which various solids are carried off, and other useful information. Copies of this booklet may be obtained by our readers on application to the firm.

Conveyors.—The Underfeed Stoker Company have secured the sole manufacturing rights for " Vibro " conveyors under the Schenck-Heymann system, the conveyors being manufactured entirely at the Company's works at Derby.

Crompton-Parkinson, Ltd.—Mr. C. J. Fox, Managing Director of The Stanton Ironworks Company, Ltd., has joined the board of Messrs. Crompton-Parkinson, Ltd., electrical engineers, of Bush House, Aldwych, W.C.2.

Welding for Pressure Vessels.

A great deal of interesting investigation has been carried out by the British Engine, Boiler and Electrical Insurance Co., Ltd., on the use of welding for pressure vessels. These investigations are described, and the inferences drawn from them stated, in the Technical Report for 1928 of the Company, now issued, price 7s. 6d. net.

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